Basic Industrial Hygiene Review

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Outline

- Noise
- Vapor & Gas Concentrations
- Ventilation

Noise

$$dB_1 = dB_0 + 20 \log \frac{d_0}{d_1}$$

Used to determine change in noise with distance.

If you measure 100 dB, 1 foot from a sand grinder during an operation, how far distance from the machine should you required hearing protection to keep the exposure at 85 dB?

$$85 = 100 + 20 \log \frac{1}{d_1}$$

Solve for $d_1 = 5.6$ feet

Noise+

You can also determine the amount of time limited to one's exposure to noise.

$$T = \frac{8}{2^{[(L-90)/5]}}$$

L is the SPL
90 is the PEL for OSHA
5 represents the dB exchange rate
(e.g., for every rise of 5 decibels of noise exposure, the time limit is cut by half)

If a worker may be required to periodically work in a shop where the noise exposure averages 103 dB. What is the total time limit that this individual can be in this room assuming no hearing protection is worn?

$$T = \frac{8}{2^{[(103-90)/5]}} = \mathbf{1.3\ hours}$$

Noise

Noise dose is calculated by the taking the individual noise exposures over time and multiplying by 100.

$$\text{Dose} = 100 \left[\Sigma \frac{C_i}{T_i} \right]$$

C indicates the total time of exposure at a specific noise level
T indicates the reference duration for that level (see previous slide)

A worker wearing a dosimeter works in various shops throughout the day. In one shop, he was exposed to 102 dB for 2 hours, in another shop to 95 dB for 3 hours, and 105 dB for 3 hours. What was the individual's dose in percent?

Calculate your T in previous slide

$T = \frac{8}{2^{[(L-90)/5)]}}$ $T_1 = 1.5$ hrs; $T_2 = 4$ hrs; $T_3 = 1$ hour

$= 100[(2/1.5) + (3/4) + (3/1)] = \underline{508\ \%}$ above the PEL

Noise

If you need to convert from noise dose to actual Time Weighted Average (TWA), use the following:

$$TWA = 16.61 \log [D/100] + 90$$

Using the previous example, what is the TWA?

$TWA = 16.61 \log [508/100] + 90 = \underline{101.7\ dB}$

Vapor and Gas Concentrations

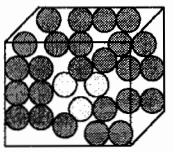
Parts per million (ppm) is a measure of concentration that is used where low levels of concentration are significant. The ppm value is equivalent to the absolute fractional amount multiplied by one million.

Often, to quantify concentrations, milligrams per cubic meter (mg/m^3) is used.

Molecular Weight: is the sum of the atomic weights of the atoms making up the molecule.

$$ppm = \frac{mg/m^3 \times 24.45}{MW}$$ Convert between ppm and mg/m3

Vapors and Gas Concentrations



3 parts of a chemical in
1 million parts of air;
or in mg/m^3 – 3 milligrams of chemical in cubic meter of air

Vapors and Gas Concentrations

When assessing exposures to PELs or TLVs, use the following expression:

$$TWA = \frac{\Sigma (c_i)(t_i)}{8}$$

c is concentration
t is the time exposed to that concentration

If a worker is exposed to toluene for 2 hours in the morning at 4 ppm, 3 hours mid-day at 6 ppm, and 3 hours in afternoon at 2 ppm, what was the workers time weighted average?

$$TWA = \frac{(2 \text{ hrs} \times 4 \text{ ppm}) + (3 \text{ hrs} \times 6 \text{ ppm}) + (3 \text{ hrs} \times 2 \text{ ppm})}{8} = 4 \text{ ppm}$$

Vapors and Gas Concentrations

Respirator Wear: Use the following expression to determine the proper respirator

$$\text{Protection Factor} = \frac{\text{Concentration Outside Respirator}}{\text{Concentration Inside Respirator}}$$

Look to the Assigned Protection Factors and choose the appropriate respirator.

Respirator Class and Type	***OSHA***	***NIOSH***
Air Purifying		
Filtering Facepiece	10	10
Half-Mask	10	10
Full-Facepiece	50	50
Powered Air Purifying		
Half-Mask	50	50
Full-Facepiece	250	50
Loose Fitting Facepiece	25	25
Hood or Helmet	25	25

http://www.osha.gov/SLTC/etools/respiratory/haz_expose/apf/apf.html

Supplied Air	***OSHA***	***NIOSH***
Half-Mask-Demand	10	10
Half-Mask-Continuous	50	50
Half-Mask-Pressure Demand	1000	1000
Full-Facepiece Demand	50	50
Full-Facepiece Continuous Flow	250	50
Full-Facepiece Pressure Demand	1000	2000
Loose Fitting Facepiece	25	25
Hood or Helmet	25	25
SCBA		
Demand	50	50
Pressure Demand	>1000	10,000

Vapors and Gas Concentrations

You have workers exposed to 1000 ppm of Toluene on average. What is the appropriate respirator type to recommend for OSHA & ACGIH? PEL = 200 ppm; TLV = 50 ppm

$$PF_{OSHA} = \frac{1000\ ppm}{200\ ppm} = 5.0 = \text{Use Half-Face Respirator}$$

$$PF_{ACGIH} = \frac{1000\ ppm}{50\ ppm} = 20 = \text{Use Full-Face Respirator}$$

Ventilation

Ventilation Flowrate: Cubic Feet per meter (cfm)
Velocity: feet per minute (fpm)

To determine the minimum flowrate required to control gas/vapor concentrations:

$Q\ (cfm) = (G)/(C)$

G = Generation Rate (Rate of Vapor Produced) - cfm
C = Concentration Required - ppm

Ventilation

When dealing with determining volumes of air required to keep below a Lower Explosive Limit (LEL), use the following:

$$C \text{ (Vapor Conc)} = \frac{LEL}{100}$$

If a process releases 2 pints of solvent per hour, each pint creating 15 cubic feet of vapor, using a Safety Factor of 5, what is the amount of ventilation required to reduce the concentration to below 1.2% LEL?

Convert solvent vapor to cubic feet per minute:
(2 pints/60 minutes) x (15 cubic feet/1 pint) = 0.5 cfm

Apply Safety Factor of 5:
0.5 cfm x 5 = 2.5 cfm

$$Q \text{ (cfm)} = (G)/(C) \qquad C = (LEL)/100 \text{ substitute into the formula}$$
$$= (G/LEL) \times 100$$
$$= (2.5/1.2) \times 100 = \mathbf{\underline{208 \text{ cfm}}}$$

Ventilation

Another expression used to determine required dilution ventilation flow rates for controlling chemical exposures.

$$Q = \frac{403 \times 10^6 \times SG \times ER \times K}{MW \times C}$$

SG = Specific Gravity
ER = Evaporation Rate (pints/minute)
K = Safety Factor
MW = Molecular Weight (grams/mole)
C = Required Concentration Level in ppm (e.g., TLV, PEL)

Group Exercises

1. During a sound survey, you notice that a safe zone at 6 feet was established around a generator. At that safe zone, you measure 88 dB. What is the estimated noise level at 1 foot from the generator?

2. If a worker was exposed to 55 ppm of Toluene for 2 hours, 60 ppm for 2 hours, and 6 hours at 0 ppm, where he worked in the office, was the worker exposed to over the TLV of 50 ppm?

Group Exercises

4. If a worker is exposed to over 500 ppm of benzene, and you want the exposure decreased to ½ of the PEL of 1 ppm, what is the minimum respirator type to recommend.

5. If a chemical has a TLV of 2 ppm but is generating vapors at 1.2 pints per 1 hour, what is the minimum ventilation flowrate needed to keep the vapors below the TLV? Specific Gravity is 2.3, Molecular Weight is 104.5, and use a safety factor of 2.

Battle Drills
Basic Industrial Hygiene

1. You receive an Industrial Hygiene report of a painting process. The laboratory reported the Formaldehyde levels at 2.1 mg/m^3, 1.5 mg/m^3, and 0.7 mg/m^3. If the OSHA Permissible Exposure Limit is 0.75 parts per million (ppm), what are these levels in ppm? The molecular weight of Formaldehyde is 30 grams/mole.

a. 1.7 ppm, 1.2 ppm, 0.57 ppm
b. 2.1 ppm, 1.5 ppm, 0.7 ppm
c. 1.7 ppm, 2.5 ppm, 0.57 ppm
d. 1.7 ppm, 0.23 ppm, 0.57 ppm

2. Recent air sampling results from your staff Industrial Hygienists show an average time-weighted average exposure to respirable Crystalline Silica at 150 mg/m^3 during a sanding operation of HMMVs at the base in order to fit new armor plating. If the Threshold Limit Value is 3 mg/m^3, and there is no local exhaust ventilation in the shop during the sanding operation, what respirator type would you recommend using the TWA above? Note: OSHA Assigned Protection Factors: 10 for Half-Face Respirators, 10 for Filtering Facepiece, 50 for Full-Face Respirators, 250 for Powered Air Purifying Respirators.

a. Filtering Facepiece
b. Half-Face Respirators
c. Full-Face Respirator
d. Powered Air Purifying Respirators

3. Seamen assigned to collateral duty at the Auto Hobby Shop were measured for noise exposures. Part of job is standing watch while other uniformed members work on their cars. On average, while standing watch in the garage area during auto work, the time-weighted average was 102 decibels (A-weighted) during an 8-hour work shift. Based on this information, what is the maximum amount of time allowed to stand watch using a 5 dB exchange rate? Assume the member does not wear hearing protection and the seamen rotate constantly from different units to this position.

a. 30 minutes
b. 40 minutes
c. 8 hours is fine.
d. 1.5 hours

4. If a painting process releases 5 pints of solvent per hour, each pint creating 50 cubic feet of vapor per the Material Safety Data Sheet, using a Safety Factor of 2, what is the required amount of ventilation to reduce the concentration to below 1.6% LEL?

a. 1430 cfm
b. 1120 cfm
c. 1313 cfm
d. 1200 cfm

5. A GS-7 working with fuel tanks is doubling duty with administrative work. Your Industrial Hygienist conducts air monitoring for benzene. She discovers that the GS-7 was exposed to his first 3 hours to 3.5 ppm benzene in the morning, goes to work in the admin office and then, return for 2 hours of fuel tank work in the afternoon and exposed to 0.9 ppm. The other 3 hours involved the administrative work. What is his time weighted average exposure to benzene?

a. 2.3 ppm
b. 1.5 ppm
c. 0.9 ppm
d. 2.0 ppm